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RECEIVED 27 February 2024

ACCEPTED 21 May 2024

PUBLISHED 07 June 2024

CITATION

von Hellfeld R, Sujiwo AS, Seeram S,
Olatunji PO, Parga Martinez K,
Govindankutty Menon A, Beckmann C,
Marigómez I and Soto M (2024) The
need for interdisciplinary research in
marine sciences – A MERry outlook.
Front. Mar. Sci. 11:1392394.
doi: 10.3389/fmars.2024.1392394

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The need for interdisciplinary research in marine sciences – A MERry outlook

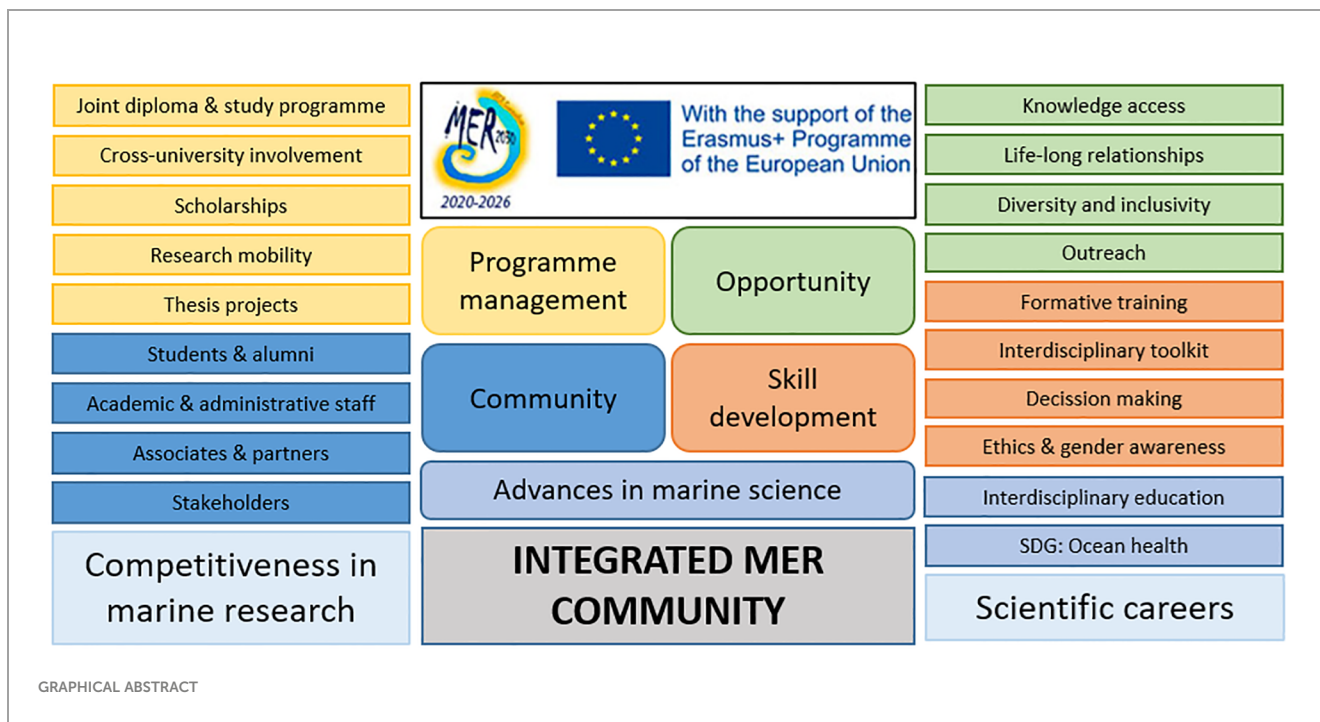
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The global oceans are facing a plethora of pressures, leading to cross-national impacts on marine ecosystems, wildlife, and resource users. Interdisciplinarity is integrating knowledge and methods from different disciplines to generate a comprehensive output. Due to the trans-boundary nature of marine habitats and stressors, interdisciplinary research forms the basis to addressing pressing matters in ocean health and conservation. To this end, the Marine Environment and Resources (MER) master programme was developed at the beginning of the century, enabling students to develop a well-rounded understanding of ocean science. The programme has since become a recognised Erasmus Mundus degree and has had almost 400 graduates. In September 2022, the first MER community summit was held, being a landmark for the building of a long-lasting global community to discuss and deal with priority challenges of the UN Decade of Oceans Science. This summit has highlighted that to understand the state of the oceans and improve conservation efforts, international collaboration is required (including those out with the academic realm). The following article aims to highlight the successes of the programme in aiding the development and training of interdisciplinary researchers from a plethora of backgrounds, uniquely suitable for addressing current problems.

KEYWORDS

global science, UN decade of ocean science, sustainable development goals, MER 2030, research outlook



1 Introduction

Our ‘Blue Planet’, covered to more than 70% with water which is a habitat for countless species, is facing unprecedented changes in current and upcoming decades. Marine biologist Sylvia Earle famously said, ‘if the sea is sick, we’ll feel it’ (Earle, 1995), and with climate change and natural disasters occurring at increasing rates, the devastating impacts of a ‘sick sea’ can be felt globally. Such impacts are perpetuated by the interdependence of organismal health with environmental conditions, which has since led to the development of what is now known as the ‘One Health’ concept (Gibbs, 2014). The concept was developed by the United Nations (UN) in 2004, to sustainably balance and optimise human, animal and ecosystem health, based on the interconnectedness of ecosystem and organismal health. It focusses on community-oriented investment involving institutional and international partners to support governance of its initiatives (Mwatondo et al., 2023). Although it may be criticised that external funding bodies from e.g., Europe or North America still hold a disproportionate influence in aspects of initiatives, the work has nonetheless highlighted the vital role that international collaborations and interdisciplinary cooperation play in global challenges¹. The decline in ocean health has prompted the initiation of the Decade of Ocean Science for Sustainable Development (2021–2030), aimed at developing global cooperation, interdisciplinary research and intersectoral collaboration to support the restoration and

maintenance of ocean ecosystems (Singh et al., 2021). The Ocean Decade is directly connected to the 2030 Agenda adopted by the UN in 2015, which calls for transformational ocean science focused on ocean dynamics and international contribution to the future of civilisation (Ryabinin et al., 2019). Here, the importance of coastal Least Developed Countries (LDCs) and Small Island Developing States (SIDS) is recognised and integrated into action plans (Ghina, 2003).

Interdisciplinary research will play a pivotal role in successfully providing transformative solutions for sustainable development and in addressing the challenges highlighted in the UN Decade of Ocean Science (UNESCO-IOC, 2021). The Global Ocean Science Report (GOSR), published to determine the current state of the oceans (Arico, 2020), emphasises the direct impact of scientific findings on management strategies, action plans, and societal benefits. Furthermore, the number of ocean science publications increases annually, largely due to contributions from Eastern and South-Eastern Asia. However, funding remains inadequate, women are underrepresented (particularly in highly technical roles), early career researchers lack recognition, and many countries are ill equipped to manage ocean data and information, all of which hamper global progress in ocean science. Addressing global challenges requires global knowledge (Ryabinin et al., 2019). This includes the experience and understanding of small communities for local ecosystems, comparability and transferability of data and observations between nations, and an unhindered exchange of insights and ideas. To address the aforementioned imbalance in global ocean science, the GOSR2020 published nine calls for action to be taken by government, organisations, scientists, and other stakeholders, including increased support women and young scientists, and fostering education and training (Arico, 2020).

¹ In the present context, the definition offered by the National Institutes of Health (NIH) will be accepted, defining interdisciplinary research as that which ‘integrates the analytical strengths of two or more often disparate scientific disciplines to solve a given biological problem’ (Aboelela et al., 2007).

Although strong high-level collaborations between established representatives of all ‘ocean health stakeholders’ are extremely important in tackling global ocean crises, a multi-generational approach is required to ensure sustainable (and sustained) contribution for the coming decades. To this end, increased focus must be placed on developing and supporting interdisciplinary research degrees, fostering a holistic approach to science, and establishing global networks. One example for the successful implementation of interdisciplinary teaching is the Erasmus Mundus Marine Environment (MER) Masters programme (www.merconsortium.eu) that was established to provide young professionals with a deep understanding of the marine environment and the ability to transfer knowledge across disciplines. The MER partnership was developed by leading European universities in the Basque Country (Spain), Southampton (United Kingdom), Bordeaux (France), Liège (Belgium), and the Azores (Portugal). The programme adopts a translational science approach, equipping students with essential skills for independent and collaborative study and management of projects. This fosters leadership in marine environment research, management, and consultancy to address the Decade challenges.

In 2022, MER celebrated its 15th anniversary with a week-long summit (the ‘MER COMMUNITY SUMMIT 2022’) featuring presentations and seminars on new methodologies and research in the marine environment by the MER community, including alumni, external presenters from various backgrounds, and associate partners. The event reinforced the programme’s mission and assessed its contributions to the Decade of Ocean Science for Sustainable Development. The following article aims to draw attention to the success of the MER programme in addressing global ocean challenges by highlighting its current contribution to supporting skill and network development of interdisciplinary researchers, supporting marine science advancement in the long-term. To this end, we offer a brief overview of the programme and its role in addressing ocean challenges in relation to the summit, supported by case studies of the programmes impact in successful interdisciplinary research.

2 The MER2030 programme

In 2006, the MER MSc was developed by the partner organisations and was included in Erasmus Mundus (EM) programmes for the first time in 2013, as the MER EMMSc (2013 – 2019). EM programmes are study programmes requiring students to attend at least three different universities, obtaining a joint degree. Its continuation, the MER+ EM Joint MSc Degree (EMJMD, 2017–2022), took into consideration the different levels of economic and social development in relevant Partner Countries. Finally, the current MER2030 EMJMD (2020–2026) aligns with EU external policy higher education priorities and responds to the UN Decade of Ocean Science for Sustainable Development 2021–2030.

MER pursues the formation of ocean science graduates specialised in diverse marine research areas. Partners offer student’s services and support joint activities, which goes beyond graduation through the

well-established alumni network and the emerging MER Community. MER2030 runs full-time for two years (120 European Credit Transfer and Accumulation System; ECTS) and consists of courses (90 ECTS) and an MSc thesis (30 ECTS). The learning outcomes are relevant to undertake multidisciplinary research and management of the marine environment. Every student follows a tailored programme, although student mobility is compulsory as students must attend at least three partner universities. The MSc thesis research can be undertaken in any partner or associate, whilst the joint viva sessions and graduation take place in the University of the Basque Country at the end of the fourth semester. MER2030 aims to achieve academic excellence in the field of marine science, based on a translational science approach, targeted to respond to the decade’s challenge, and to provide scientific support to environmental policies [e.g., EU Marine Framework Strategy Directive; MFS (European Union, 2008)]. MER2030 enhances the mobility of students and staff and facilitates mutual learning and cooperation through the EM requirement to attend at least three universities during the course, meaning that students live and work in different countries as part of the degree. Training and advice are provided to enhance career prospects and employability of the graduates (e.g., through internships, professional placements, early-stage-career training, and social media). Finally, graduates are prepared to be active citizens in inclusive societies where intercultural understanding, critical thinking, tolerant attitudes, gender equality and civic values are crucial.

MER2030 provides the student with competences and skills to study independently and manage projects, thus fostering leadership in marine environment research, consultancy, and management. A sense of community is reflected in every aspect of the programme; from promotion to quality assurance (QA), through selection, administration, services, teaching, exams and marks, networking and, most outstandingly, joint degree awarding. The European Approach for Quality Assurance of Joint Programmes (EA, <https://www.eqar.eu/kb/joint-programmes/>), adopted by European Ministers responsible for higher education, has been developed to ease external quality assurance of these programmes: It defines standards that are based on the agreed tools of the European Higher Education Area and Bologna Process (EHEA, <https://ehea.info>), without applying additional national criteria. In 2023, MER2030 was awarded with this EA label since contributes to work out strategies for sustainability and for the career prospects of its graduates. Moreover, MER2030 has had its Good Practice Label (GPL) renewed in 2024 by the European Commission’s European Education and Culture Executive Agency (EACEA, https://www.eacea.ec.europa.eu/index_en). To award the prestigious GPL, the European Commission takes into consideration the appraisal, the relevance of the results and alignment with the objectives, the overall quality of management and the degree of implementation, its impact and dissemination, among other criteria.

2.1 MER in numbers

Since the beginning of the MER programme, including non-EM cohorts (2006/2007–2012/2013) and EM cohorts (2013/2014– 2022/2023), 397 students have graduated. The provenance of students is

mainly from partner countries (47%), consortium countries (39%) and self-funded students, from both program and partner countries (14%). The rest of students (5%) came from program countries. Since 2019, the Cousteau Foundation nominates the best MSc thesis research in marine environmental conservation for their ‘Calypso Prize’, which is ratified by the joint program board during the graduation ceremony ([Supplementary File 1](#)). Further, since 2018 the joint MSc thesis examination board proposes 1–2 nominees of each cohort to be recognised with the ‘Prof. MB Collins Award’ for the best presentation. This award is offered since 2018, in memory of the MER Consortium pioneering promoter (see [Supplementary Table 1](#)). Moreover, since 2018, students from more than 50 countries were accepted into the MER programme, as shown in [Figure 1](#).

2.2 Ocean challenges and the MER community

The MER COMMUNITY SUMMIT 2022 was designed to be a landmark for the building and supporting of a long-lasting global MER community by gathering graduates from 15 cohorts, along with staff, stakeholders, and employers. The event facilitated interdisciplinary discourse among past and current students, as well as with worldwide-recognised scientists as guest lecturers and keynote speakers from diverse backgrounds. The event had over 250 attendees, including participants from 12 programme- and 28 partner-countries. Representatives of non-academic institutions included e.g., the Intergovernmental Oceanographic Commission of UNESCO (France), Scientific Committee on Oceanic Research, Spanish National Research Council (Spain), AZTI Marine Research (Spain), The Bottlenose Dolphin Research (Spain), United Nations Conference on Trade and Development (Switzerland), Water Science Policy (Germany), Kenya Marine Fisheries Socio-Economic Development Project, Wildlife Conservation Society (Kenya), Wildlife Conservation Society (Tanzania), and the

Secretary of Aquaculture and Fisheries of Ministry of Agriculture, Livestock and Food Supply (Brazil).

Internationally renowned scientists contributed as guest lecturers and keynote speakers, whilst 36 oral presentations and 24 poster contributions were included in the scientific sessions. These dealt with priority challenges of the UN Decade of Oceans Science, including observatories and monitoring systems, environmental protection and management, marine pollution, biodiversity conservation, integrated coastal zone management, global ocean change and climate crisis, sustainable management of biological resources, marine biotechnology, and socio-economic aspects (including ocean literacy, environmental awareness, and blue economy). Additionally, four community building sessions, focussing on (1) alumni and students, (2) associates, (3) stakeholders, and (4) women in science, were developed and delivered by MER students, alumni, and staff. These aimed to allow for open discussions and feedback from all participants on the sessions matters, improving the integration of these groups into the MER programme going forward. Lastly, two alumni-led workshops were offered, addressing (1) multilingual science communication and (2) the link between communities and the ocean (‘The people are the sea’). These workshops highlighted the significance of including not just scientists from diverse background in ocean research projects, but also the value of community involvement, as well as the need for scientific findings to be available in key terms and relevant languages, to facilitate e.g., the incorporation of recommendations or future community involvement.

3 The impact of MER

The interdisciplinary nature of the programme goes beyond the curriculum, as students are offered the opportunity to develop their own thesis projects in collaboration with external supervisors in addition to those offered by the consortium. Over the years, this has led to the completion of a variety of interdisciplinary projects ([Table 1](#)). Although some of the projects were conducted prior to

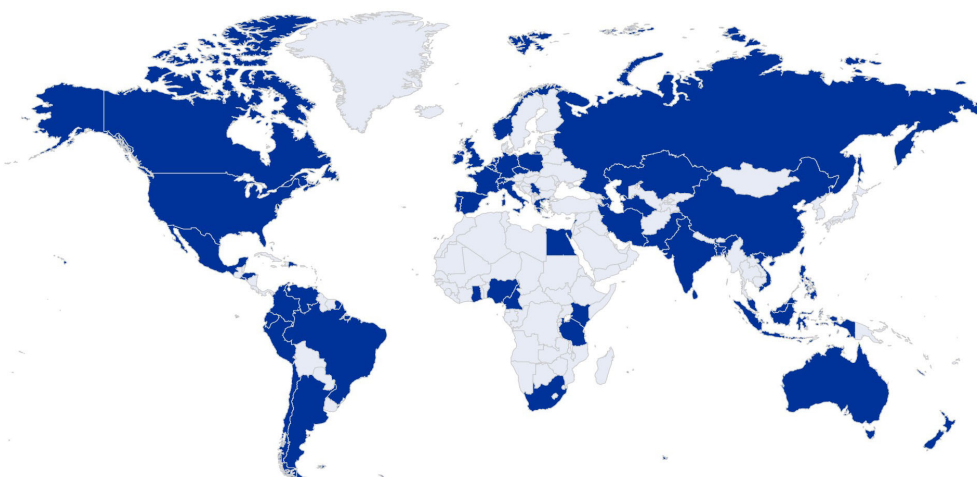


FIGURE 1

World map highlighting countries of origin for all accepted MER students since 2018 (blue). A list of all countries can be found in [Supplementary Table 2](#).

TABLE 1 Non-exhaustive list of interdisciplinary master thesis projects, highlighting the UN Sustainable Development Goals (SDGs) and Ocean Decade Challenges related to these projects.

Thesis projects details	UN SDGs and Ocean Decade Challenges
<p>Eleni Stogianou (2013). An LCA study considering the taxiway and runway expansion of the Macedonia Airport in Thessaloniki, Greece, using GEMIS 4.5 tool. Supervisor: Yannis Krestenitis (University of Thessaloniki, Greece).</p>	<p><u>UN SDG goals:</u></p> <ul style="list-style-type: none"> • 9 (Industry, innovation, and infrastructure). • 11 (Sustainable cities and communities). • 14 (Life below water); Goal 15 (Life on land). <p><u>Ocean Decade challenges:</u></p> <ul style="list-style-type: none"> • 2 (Protect and restore ecosystems and biodiversity). • 4 (Develop a sustainable and equitable ocean economy). • 6 (Increase community resilience to ocean hazards).
<p>Renee McDonald (2013). Assessing geohazards in Kingston, Jamaica. Supervisor: Mattew Hornbach (Southern Methodist University, USA).</p>	<p><u>UN SDG goals:</u></p> <ul style="list-style-type: none"> • 11 (Sustainable cities and communities). • 13 (Climate action). • 14 (Life below water). • 15 (Life on land). <p><u>Ocean Decade challenges:</u></p> <ul style="list-style-type: none"> • 6 (Increase community resilience to ocean hazards). • 10 (Change humanity’s relationship with the ocean).
<p>Maria Sanjaya (2016). Assessment of spatial conflict between aquaculture and artisanal fishing activities: A case study in the Basque continental shelf. Supervisors: Ibon Galparsoro & Arantza Murillas (AZTI, Spain).</p>	<p><u>UN SDG goals:</u></p> <ul style="list-style-type: none"> • 2 (Zero hunger). • 14 (Life below water). <p><u>Ocean Decade challenges:</u></p> <ul style="list-style-type: none"> • 3 (Sustainably feed the global population). • 4 (Develop a sustainable and equitable ocean economy). • 8 (Create a digital representation of the ocean).
<p>Itziar Burgues (2017). An application of an interdisciplinary approach to understand the interactions between marine recreational activities and natural capital in the Basque Country. Supervisors: Arantza Murillas & Maria Calvo Uyarra (AZTI, Spain).</p>	<p><u>UN SDG goals:</u></p> <ul style="list-style-type: none"> • 10 (Reduce inequalities). • 11 (Sustainable cities and communities). • 14 (Life below water). <p><u>Ocean Decade challenges:</u></p> <ul style="list-style-type: none"> • 8 (Create a digital representation of the ocean). • 10 (Change humanity’s relationship with the ocean).
<p>Caroline Coccoli (2017). Reallocation scenarios for artisanal fishing effort in the presence of an aquaculture site: A GIS-integrated Bayesian belief network for spatial conflict resolution in the Bay of Biscay. Supervisors: Ibon Galparsoro & Arantza Murillas (AZTI, Spain).</p>	<p><u>UN SDG goals:</u></p> <ul style="list-style-type: none"> • 2 (Zero hunger). • 10 (Reduce inequalities). • 11 (Sustainable cities and communities). • 14 (Life below water). <p><u>Ocean Decade challenges:</u></p> <ul style="list-style-type: none"> • 3 (Sustainably feed the global population). • 4 (Develop a sustainable and equitable ocean economy). • 8 (Create a digital representation of the ocean). • 10 (Change humanity’s relationship with the ocean).
<p>Jordan Gacutan (2018). Linking natural capital to maritime activities: Operationalizing the ecosystem service cascade framework along the Basque coast (SE Bay of Biscay). Supervisors: Ibon Galparsoro & Arantza Murillas (AZTI, Spain).</p>	<p><u>UN SDG goals:</u></p> <ul style="list-style-type: none"> • 10 (Reduce inequalities). • 11 (Sustainable cities and communities). • 14 (Life below water). <p><u>Ocean Decade challenges:</u></p> <ul style="list-style-type: none"> • 2 (Protect and restore ecosystems and biodiversity). • 4 (Develop a sustainable and equitable ocean economy). • 8 (Create a digital representation of the ocean). • 10 (Change humanity’s relationship with the ocean).
<p>Imanol Aguirre (2018). Marine Protected Areas expose significant links between socioeconomic and ecological variables kept from sight in unprotected areas. Supervisor: Mikel Becerro (CSIC, Spain).</p>	<p><u>UN SDG goals:</u></p> <ul style="list-style-type: none"> • 11 (Sustainable cities and communities). • 14 (Life below water). <p><u>Ocean Decade challenges:</u></p> <ul style="list-style-type: none"> • 2 (Protect and restore ecosystems and biodiversity). • 3 (Sustainably feed the global population). • 4 (Develop a sustainable and equitable ocean economy). • 8 (Create a digital representation of the ocean). • 10 (Change humanity’s relationship with the ocean).
<p>Anne Le Henaff (2019). A social network analysis on organisations collaborating on coastal restoration projects. Supervisor: Steven Scyphers (Northeastern University, United States).</p>	<p><u>UN SDG goals:</u></p> <ul style="list-style-type: none"> • 10 (Reduce inequalities). • 11 (Sustainable cities and communities).

(Continued)

TABLE 1 Continued

Thesis projects details	UN SDGs and Ocean Decade Challenges
	<ul style="list-style-type: none"> • 14 (Life below water). • 15 (Life on land). • 17 (Partnerships for the goals). <p><u>Ocean Decade challenges:</u></p> <ul style="list-style-type: none"> • 2 (Protect and restore ecosystems and biodiversity). • 4 (Develop a sustainable and equitable ocean economy). • 8 (Create a digital representation of the ocean). • 10 (Change humanity’s relationship with the ocean).
<p>Elizabeth Sherr (2020). The role of science and a scientific body in the future United Nations Treaty for Conservation and Sustainable Use of BBNJ (Biodiversity Beyond National Jurisdiction). Supervisor: Carlos Garcia-Soto (IEO, Spain).</p>	<p><u>UN SDG goals:</u></p> <ul style="list-style-type: none"> • 13 (Climate action). • 11 (Sustainable cities and communities). • 14 (Life below water). • 15 (Life on land). • 17 (Partnerships for the goals). <p><u>Ocean Decade challenges:</u></p> <ul style="list-style-type: none"> • 2 (Protect and restore ecosystems and biodiversity). • 4 (Develop a sustainable and equitable ocean economy).

the adoption of the 2030 Agenda for sustainable development goals in 2016 or the start of the UN Ocean Decade in 2021, the projects already addressed aspects of such global actions.

Selected case studies from Table 1 indicate not only the interdisciplinary nature of the projects, but also the potential for wider impact and career development. Itziar Burgues’ research on marine recreational activities, presented at Coast Bordeaux 2017, was integrated in the scientific report of the International Council for the Exploration of the Seas (ICES) working group on resilience and marine ecosystem services (ICES, 2021). ICES acts as the regional fishery advisory body and is also the world’s oldest intergovernmental science organization. Within the context of the ICES report, the work conducted by Itziar Burgues has contributed to the development of the Ocean’s Benefits to People (OBP) framework which builds on blue economy, equity, and the UN SDGs, and supports marine Ecosystem-Based Management (EBM).

Similarly, Caroline Coccoli’s work on relocation of artisanal fisheries in the Bay of Biscay offers conflict resolutions for otherwise incompatible user-user requirements of marine spaces in an sustainable manner (Coccoli et al., 2018). The work further highlights the need to consider existing and traditional maritime activities in the context of blue growth strategies, building on expert knowledge as well as imperial data. This publication has been cited by 8 policy documents, including those on artificial intelligence in the fisheries sector (European Parliament, Directorate General for Internal Policies of the Union, 2022), the impact of offshore industries on fisheries (European Parliament, Directorate General for Internal Policies of the Union, 2020), maritime spatial planning (Executive Agency for Small and Medium sized Enterprises et al., 2020), the Wales maritime evidence report (CEFAS, 2020), and the global Atlas of AIS-based fisheries activities (Taconet et al., 2019).

Finally, Elizabeth Sherr’s work on the role of the UN Treaty for Conservation and Sustainable Use of Marine Biodiversity and Areas Beyond National Jurisdiction (BBNJ) was presented at the UN Ocean Decade Conference in April 2024, reaching a broad audience of policy makers, industry stakeholders, and scientists. These are selected examples of outstanding projects developed within the

MER consortium. An exhaustive list of previous master thesis abstract can be accessed via on the following website: <https://merconsortium.eu/msc-thesis/msc-thesis-list/>.

4 Future perspectives of MER

Marine environmental protection and the sustainable use of its resources are regulated in EU by environmental directives and policies such as the Water Framework Directive (European Union, 2000) or the Marine Strategy Framework Directive (European Union, 2008), highlighting the necessity for international cooperation especially among regions bordering European seas. This necessity underlines the self-sustaining nature of the MER programme, by actively training students in various interdisciplinary aspects of marine science as highlighted above. Further increasing the success of the programme, the MER programme is actively seeking students from regions bordering the Mediterranean Sea, such as the Eastern partnership countries and South-Mediterranean countries. Furthermore, the most vulnerable marine ecosystems worldwide are located in developing countries, such as those in the tropical belt from Latin America to Africa and South-East Asia. Thus, similar efforts have been made to increase applications from students of these regions, as evidenced by Figure 1. Our vision is that graduates for a leadership role in environmental research and management are needed both at local and global scales. These graduates are the next generation of scientists and managers who need to understand the marine environment at a global ocean scale, and to solve environmental problems of the seas at regional scale.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material. Further inquiries can be directed to the corresponding author.

Author contributions

RV: Writing – review & editing, Writing – original draft, Visualization, Supervision, Project administration, Methodology, Investigation, Conceptualization. AS: Writing – review & editing, Writing – original draft, Visualization, Methodology. SS: Writing – review & editing, Visualization, Validation, Investigation. PO: Writing – review & editing, Validation, Resources, Investigation. KP: Writing – review & editing, Validation, Investigation. AG: Writing – review & editing, Validation. CB: Writing – review & editing. IM: Writing – review & editing, Validation, Data curation, Resources, Funding acquisition. MS: Writing – review & editing, Writing – original draft, Validation, Resources, Funding acquisition, Conceptualization.

Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

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Conflict of interest

Author SS was employed by company Coastal Dynamics Limited. The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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